POSSIBLE SITES FOR BAMBOO PAPER-PULP MILLS IN THE BOMBAY PRESIDENCY.

NOTE.—Since these areas were inspected, flowering of the Daugi bamboo has been reported to have taken place but to what extent is not known. This may render some of the areas unworkable for a few years, though the period required for recovery is generally short.

AREA NO. I. (*See portion marked* **A** *on map.*)

The Gangavalli Catchment Area in the Ankola and Yellapur Ranges of the West and East Kanara Forest Divisions.

(1) *Name and Situation.*

The area is situated on the West Coast of the Bombay Presidency in the Kanara Collectorate and comprises the catchment area of a large river, known as the Gangavalli in its lower reaches, and as the Bedti River where it pierces the Ghats. The valley formed by this river is fairly broad, for a distance of 8 to 10 miles from the coast, and gradually narrows as it approaches the Western Ghats, which lie some 40 miles from its mouth. On its course down the Ghats it passes through narrow gorges and forms a rushing stream, with many small waterfalls. On the plateau it is a narrow stream which in its upper reaches nearly dries up in the hot weather. From the sea to the foot of the Ghats the river is bounded on each side by high spurs and chains of hills jutting out of the Deccan plateau, which gradually disappear on approaching the coast. Small tributaries coming from the surrounding hills flow into the river on either side.

(2) *Description of the forests.*

The forest is what is known as moist deciduous. It contains a great variety of species, intermixed with large quantities of bamboos, of the species known as *Bambusa arundinacea* (Daugi), which, though it occurs nearly all over the area, is especially abundant on the more level ground on each side of the main stream and up the by-valleys. The finest growth is found in the upper limits of the valley round the Ramangulli, Arbail and Shavkar cultivations, and everywhere along the banks of the streams. On the slopes the growth is less luxuriant and the clumps

Pearson.—Utilization of Bamboos in the Manufacture of Paper-pulp.

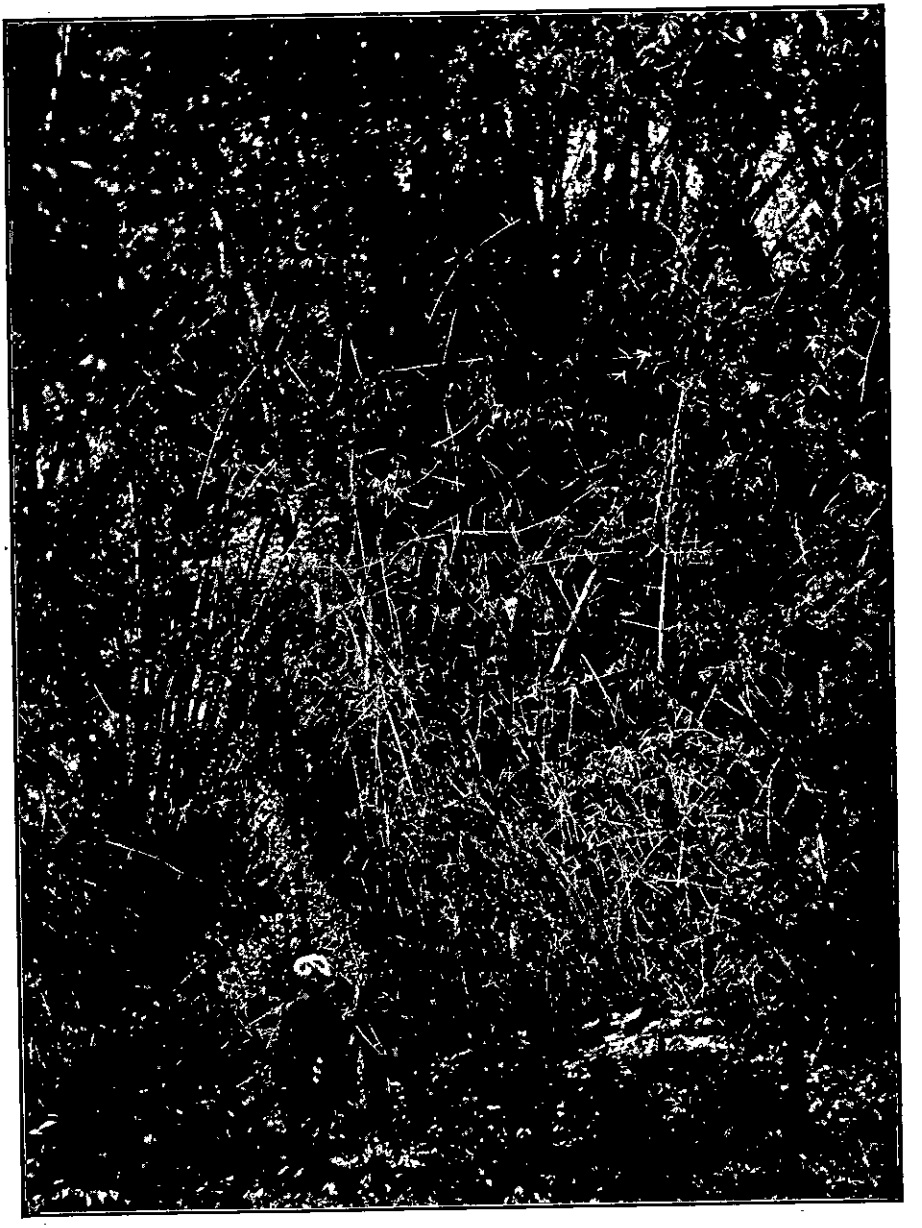

Photo.-Mechl. & Litho. Dept., Thomason College, Roorkee.

Photo by R. R. Chandilkar, Forest Surveyor.

Bambusa arundinacea Forest, West Kanara Forest Division, Bombay Presidency.

more scattered, being generally denser along the dry rivulets than on the faces of the slopes.

(3) *Area of forest covered by bamboos.*

The area covered by bamboos which can be worked out to the main stream is 68,723 acres, of which 38,643 acres have been classified as first class bamboo area, and 30,080 acres as second class, owing to the relative poorness of the crop. From the map will be seen the general position of the area with reference to the coast-line.

(4) *Species of bamboos and mode of growth.*

The chief species occurring in the area is *Bambusa arundinacea*, a large bamboo, which in the more favourable localities above referred to grows 60 to 80 feet in height and 8 inches mid-girth. In the 2nd class areas it is about 30 feet in length and 6 inches mid-girth.

The number of clumps, obtained by counting six sample plots in 1st class area worked out to 64 per acre, containing a total of 149 new culms under one year old and 306 culms over one year old or a total of 455 culms per acre. These figures are taken into consideration hereafter in calculating the possible yield. A very marked feature in the growth of this species of bamboo is the sheath of the side-shoots, armed with recurved points, resembling thorns, which forms a complete palisade to a height of 6 to 8 feet from the ground round each clump, and which renders extraction more difficult than is the case with the unarmed species.

(5) *Possible factory site.*

The most suitable factory site is at the village of Gumbala situated on the banks of the Gangavalli, above the tidal level, some 14 miles from the sea (see map).

The area, in which the bamboos are most plentiful, starts just above Gumbala and stretches for 24 miles up the valley to the village of Arbail at the foot of the Ghats. The stream is suitable for floating over its entire length, except during the summer months, and possibly during the first two months of the rains. There exists a small Bunder or port on the coast, on a neck of land jutting into the sea, south of the mouth of the river at Tadri, which is a calling place for

Shepherd's steamers. The river at Gumbala is some 200 yards broad, and always contains a plentiful supply of fresh water, while small boats of 5 tons burden can reach it from the sea. It is for this reason, as also from the fact that the place is fairly healthy and open, that it has been chosen as a suitable site for a pulp-mill.

(6) *Outturn.*

The outturn is based on the eight sample plots taken in different parts of the area. The work was carried out by Mr. Miller, the Divisional Forest Officer, his Assistant Mr. Kotwal, and the writer of this report, when the latter was on tour in that District. Owing to the bamboo growth being heavy on the more level ground and lighter on the slopes, it has been considered necessary, for greater accuracy, to divide the forest into two quality areas.

The total area of bamboo-yielding forest is computed at 68,723 acres, the figure having been arrived at by the use of a planimeter. Of this, 38,643 acres are first class and 30,080 acres are second class bamboo forests. Referring to Appendix IV, sample plots Nos. 1 to 6, we get 10,149 lbs. per acre as the average outturn of dry internodes in first class areas, and from sample plots Nos. 7 and 8, 1,975 lbs. per acre in the second class areas. The total gross yield for the whole area, taking into consideration the areas of the two quality classes and their yield per acre, therefore, works out to 451,595,807 lbs. or 201,605 tons. The question as to a suitable rotation on which to cut bamboos has been already discussed in Part II, and has been fixed at 5 years, so that the total sustained yield of dry internodes works out to 40,321 tons per annum. As it will probably be found possible to treat the nodes together with the internodes the annual yield may be raised by 15 per cent.

(7) *Lines of export.*

There are two methods by which the bamboos can be exported (1) by floating down the Gangavalli river and (2) by carting along the Yellapur-Karwar road which runs down the entire length of the valley close to the river. It would be necessary to drag the bamboos to the edge of the river or road, a maximum distance of three miles, but, generally speaking, not one-third of that distance, and afterwards either to float them in rafts down the river or cart them along the road.

It would, however, only be necessary to resort to the latter method in time of high flood or during the summer months.

(8) *Cost of extraction.*

(*i*) *By floating.*—Owing to the thorny palisade above-mentioned, which exists round each clump, the cost of cutting is estimated at Rs. 6 per 100, which is a high figure, the cost of dragging to the river is put at Rs. 3 per 100, and the cost of floating down the river from the centre of the area to Gumbala is put at Rs. 2 per 100, a total of Rs. 11 per 100.

(*ii*) *By carting.*—The average distance is estimated at 12 miles by cart-road. A cart holds 33 bamboos and the rate per cart is 2 annas a mile. This works out to Rs. 6-12 per 100 by cart, to which must be added Rs. 9, the cost of cutting and dragging to the road, which works out to a total of Rs. 15-12 delivered at Gumbala. To this must be added royalty charges. The price of bamboos on the coast is Rs. 10 to 12 per 100, of 20 feet length.

(9) *Cost of landing air-dry internodes per ton at the factory.*

From the results obtained by weighing culms cut in the sample plots (see Appendix IV), we get the following figures :—

Total number of culms cut.	Total weight air-dried, in lbs.	Weight of nodes and saw-dust, in lbs.	Weight of air-dried internodes, in lbs.	Weight of dry internodes per 100 culms, in lbs.	Number of culms required to yield one ton of dry internodes.	Cost of one ton of dry internodes at Gumbala.
554	16,234	2,372	13,862	2,502	89·5 in round figures 90.	Rs. 9-14-5 by floating and Rs. 13-8-0 if carted.

The above calculations are based on a fairly large number of culms cut from various parts of the area, in good, fair and indifferent bamboo forests. The culms were weighed green, and again after the nodes had been cut out and the culms had been allowed to dry for about four months.

(For details see Appendix IV.) The cost of landing dry internodes at Gumbala works out roughly to Rs. 10 per ton, which figure probably could be reduced considerably by working on a large scale and after further experience.

(10) *Labour.*

Part of the cooly labour could be procured from the coast villages, but importation of labour on a fairly extensive scale would be necessary, especially during the harvesting season, when the local population return to their homes to reap the rice crop. The price of labour is 5 to 7 annas a day for men and $2\frac{1}{2}$ to 3 annas for women and children. As regards the artisan class, with the exception of carpenters and a limited number of masons, they would have to be imported.

(11) *Chemicals.*

All chemicals, with the exception of lime, will have to be imported. The cost, however, would not be heavy as they can all be brought by sea and by sailing boats up the river. Large quantities of excellent shell-lime are available on the coast at a cost of 12 annas per cwt.

(12) *Fuel.*

Firewood is plentiful and can be obtained from the area in which the bamboos are found. The price fluctuates considerably, being generally high, owing to the proximity of the Bombay market. The price of coal would be very much the same as in Bombay.

(13) *Miscellaneous facts.*

Climate is an important factor in considering the suitability of a paper-pulp factory site. The upper reaches of the valley are, without doubt, very malarious during the winter months. On the other hand, the coast country and the country as far inland as Gumbala, is healthy, and quite fit for Europeans to live in throughout the year. The supply of meat food is very deficient, though fowls and excellent fish are always procurable.

AREA NO. II. (*See portion marked B on map.*)

The Kala Nadi Catchment Area in the Karwar and Supa Ranges of the West and North Kanara Forest Divisions.

(1) *Name and Situation.*

The area is situated on the West Coast of the Bombay Presidency in the North Kanara Collectorate and consists of the catchment area of a river known as the Kala Nadi, which taps the upper slopes of the Western Ghats and finds its way to the sea at Karwar, the head-quarters of the District and a small port, situated in a very fine bay. The valley, formed by this river, is fairly broad and open as far as Kadra, some 20 miles from the sea, and in this area, which is under cultivation, there are relatively few bamboos, except along the banks. Above Kadra the valley gradually narrows in, until above Bobrigadda it forms a ravine, through which the river passes in a deep channel some 100 yards broad. The hills, on each side of the river above Kadra, rise to over 2,000 feet and are clothed throughout with fine high forest. The village of Bobrigadda is about 40 miles from the sea. Above this village, the river, which is still a fine one, passes through the Gund slopes to the foot of the Ghats. The slopes on either side are covered with heavy teak and bamboo forests. The extreme limits, from which it would probably be practicable to exploit bamboos, is 40 miles above Kadra, or a distance of 60 miles from the sea.

(2) *Description of the forests.*

In the lower reaches, especially near the river and up its tributaries, there occur moist deciduous forests, while the greater portion of the lower and middle slopes are covered with dry deciduous forest, containing, above Birkol village, a fair quantity of teak and bamboo forest. The higher slopes are generally covered with evergreen forest, in which no bamboos are found. The prevailing species of bamboo is *Bambusa arundinacea*, known locally as the "Daugi" bamboo. It grows to a large size in the lower areas and is still of fair size on the dry slopes, while, on the Gund plateau above, an area also included in this scheme, it is found growing to a great size. The other bamboos found in these forests are *Dendrocalamus strictus* and *Oxytenanthera monostigma*, of which the former species in particular is not common.

(3) *Area of the forests covered with bamboos.*

The total area in which bamboos are found between Kadra village and the Shivpur Nala, a stretch of the valley covering some 30 miles, is computed to be 20,374 acres. Of this, 14,264 acres are classed as 1st class, and 6,110 acres as 2nd class bamboo forest—the figures based on enumerations made in the Working-Plans. To the above figures must be added the Gund area, which is a continuation of the Kala Nadi forests, in which the Divisional Forest Officer, Mr. Copleston, estimates 7,000 acres to be of the 1st class, giving a total of 27,374 acres of bamboo forest.

(4) *Species of bamboo and mode of growth.*

The common bamboo in these forests is *Bambusa arundinacea*, growing from 60 to 80 feet in height and 8″ mid-girth in the lower parts of the valley and to an even larger size on the Gund slopes, while on the drier slopes it attains a height of 50 feet and 6″ mid-girth. It is found fringing the banks of the main stream throughout its length, and is plentiful on the more level ground, especially near Sulgeri, Birkol, Devkar and above Bobrigadda, as also in Gund, while on the warmer slopes of the hills, it is found in scattered clumps, being densest up the dry rivulets.

(5) *Possible factory site.*

The best place for a factory would be just above tidal level, on the north bank of the river between Kadra and Balamani villages. Here the river is over 100 yards broad and flows with a strong current throughout the year. Five-ton sailing boats come up daily to Kadra, and from there to the factory would be under two miles, or a total distance of under 24 miles from Karwar harbour. There would be no question of want of water near Balamani, as the river never approaches a state of dryness at any time of the year. There is also plenty of open land on the north side of the river, on which a large mill could be erected.

(6) *Outturn.*

In estimating the outturn of bamboos from these forests, it will be necessary only to consider *Bambusa arundinacea*, as the other two species, *i.e.*, *Oxytenanthera monostigma* and *Dendrocalamus strictus* are not found in sufficient quantities to justify their inclusion in the estimate.

The conditions in this valley are identical with those in the neighbouring Ankola valley, which have been discussed above, so that the figures obtained by enumerating sample plots in that area will be applied here also. The growth in the Gund area being considered superior to that in the Kala Nudi or Gangavalli valleys, separate enumerations have been carried out, with a view to obtaining more reliable results.

The area of 1st class bamboo forest in the valley proper is 14,264 acres, while the outturn, according to figures given in Appendix IV, show a yield of 10,149 lbs. per acre, or a total outturn of 144,765,336 lbs. or 64,627 tons.

The 2nd class area in the valley covers 6,110 acres. From Appendix IV, we see that the yield per acre in this class of forest is 1,975 lbs. per acre or a total yield of 12,067,250 lbs. or 5,387 tons.

In the Gund plateau there are 7,000 acres of 1st class forest. From the figures of the enumerations of five sample plots (see Appendix IV), it will be seen that the yield of dry internodes per acre is 28,968 lbs. giving a total yield of 202,776,000 lbs. or 90,520 tons.

Therefore the gross yield stands as follows :—

	Tons.
1st class area in valley	64,627
2nd class „ „	5,387
Gund area	90,520
	160,534

As has been explained in Part II, the rotation is fixed at five years so that the sustained yield works out to 32,107 tons of dry internodes per annum. As explained under (6) Outturn, page 78, this estimate would be raised by 15 per cent. by including the nodes.

(7) *Lines of export.*

The Kala Nadi river is a broad stream which drains the whole area. Floating is possible from September to March and even later, as water flows in the channel throughout the year. Owing, however, to rapids above Kadra and again below Bobrigadda, floating is difficult unless the supply of water is considerable. In the case of the valley forests, the distance, from which bamboo will have to be dragged to the stream, never

exceeds two miles, while in most cases it will not be half that distance. In the case of the bamboos to be procured from the Gund plateau, which lies in the upper reaches of the river, they will have to be dragged a maximum distance of three miles to the edge of the plateau and then be slid down the steep sides of the Ghats to the river bank. There also exists a very fair road suitable for carts on the right bank of the stream from Kadra to Sulgeri, which is to be extended to Bobrigadda. The question of extraction, provided cooly labour is available, presents no serious difficulties.

(8) *Cost of cutting and extraction.*

As before stated, the extraction of the culms is rendered difficult owing to the palisade of thorns round the base of the clumps. The cost of cutting 100 culms is therefore put at Rs. 6 throughout. The cost of dragging to the river, a maximum distance of two miles, is put at Rs. 2 for the valley forests and Rs. 4 from Gund, while the cost of floating 100 bamboos from the centre of the area near Bobrigadda would be Rs. 2 and from Gund Rs. 5. The total cost of extraction, therefore, works out to Rs. 10 from the valley and Rs. 15 per 100 from Gund. The market rate for bamboos at Karwar, including royalty, is Rs. 10 to Rs. 14 per 100, according to quality.

(9) *Cost of landing air-dried internodes per ton at the factory site.*

The figures for the valley forests are taken from paragraph 9, page 79, of the Ankola valley scheme, and as the cost of landing green bamboos at Balamani is Rs. 10, the cost of delivery of the dry internodes at the factory site, obtained from the valley forests, works out at Rs. 9 per ton. Separate figures for Gund are given in Appendix IV. The internodes from one bamboo weigh 68 lbs, therefore the number of bamboos required to make a ton of air-dried tubes is in round figures 33, the cost of landing which at the factory site comes to Rs 4-15-2. The reason why it is cheaper to deliver one ton of air-dried internodes from the further area is that the individual culms from that area (Gund) are much larger and heavier than those found in the valley forests, while the actual labour required for their extraction is not in proportion to their size owing to the facility of floating them down the river.

(10) *Labour.*

No great number of coolies is available in the neighbourhood, as the coolies, who are in the habit of working in the forests, are employed in working the fuel coupes. It would, therefore, be necessary to import labour from Goa territory, Ratnagiri District and Savantwadi State. Cooly wages are from 4 to 7 annas a day, according to the season of the year, and women and children can earn 2½ to 3 annas a day. Carpenters and masons demand 12 annas to Re. 1 per day.

(11) *Chemicals.*

All chemicals, with the exception of lime, will have to be imported, though the cost of doing so will not be heavy, as they can be brought by sea to Karwar in steamers and in sailing boats of three to five-ton burden up the river as far as Kadra. Large quantities of excellent shell-lime are procurable on the coast, at a cost of 12 annas per cwt.

(12) *Firewood.*

Firewood is available in fair quantities, but it would not be sufficient to run a large mill. Coal would have to be imported, the price being about the same as in Bombay. The price of fuel is high, as much as Rs. 10 to 12 per ton, owing to the facility of export by sea to Bombay.

(13) *Miscellaneous facts.*

The climate in this valley is, on the whole better than in the neighbouring valley of Ankola, for which a scheme has been prepared in the foregoing pages. The climate in and around the proposed factory sites in both areas is about the same, but the upper reaches of the Ankola valley compare unfavourably with those of the Kala Nadi. A small port is situated at the mouth of the river at Kodibag, from which timber is exported up and down the coast. In the monsoon months the entrance is dangerous for ships, owing to the bar. The harbour is within two miles of Karwar, the headquarters of the North Kanara Collectorate, which is considered a healthy place for the West Coast.

Area No. III. (*See portion marked* **C** *on map.*)

The Mungod Forests of the East Kanara Forest Division.

(1) *Name and Situation.*

The area is situated on the Deccan plateau, stretching from the edge of the Western Ghats inland for a distance of above 20 miles. It is situated in the Yellapur and Mungod Ranges of the East Kanara Forest Division of the North Kanara Collectorate. The configuration of the land is characterised by an undulating plain, which is cut into by small rivulets, the southern portion being the upper catchment area of a river, known in its upper reaches as the Bedti and as the Gangavalli as it approaches the sea. The northern portion of the area is tapped by the Kala Nadi which runs more or less parallel to the Gangavalli, and finds an outlet into the sea at Karwar (see map).

(2) *Description of the forests.*

The area is covered with dry deciduous forests, while, here and there along the rivulets and on low-lying areas, evergreens occur. It is well stocked with trees and bamboos are found everywhere.

(3) *Area of the forests covered with bamboos.*

The whole area consists of bamboo forest of a practically uniform type. It has been divided into five blocks in the Working-Plan, of which the portions contemplated in this scheme are as follows :—

Block No.	Acres.
XIII	25,000
XIV	20,000
XV	21,000
XVI	8,000
XVIII (part)	5,000
XXIII (part)	34,000
Total	113,000

As the growth of the bamboos is fairly uniform throughout, the whole area has been grouped into one quality class.

(4) *Species of bamboos and mode of growth.*

The common bamboo in these forests is *Bambusa arundinacea*, which grows from 40 to 50 feet in height and 8″ mid-girth (see Appendix V). Portions of the area are densely stocked with this species and it is everywhere plentiful. It is not extracted to any great extent, the number taken out in 1908-09 being 14,500 only. The other bamboo found is *Dendrocalamus strictus* which, as compared with *Bambusa arundinacea*, is not plentiful, though fully sufficient to meet the local market.

(5) *Possible factory site.*

There are two possible factory sites. One is at Bomanhalli, also known as Kegdal, which is situated some five miles from the north-western limits of the area, on the Kala Nadi river. From the bamboo forest and leading to this place are several good cart-roads, while from the proposed factory site to Alnavar, a station on the Madras and Southern Mahratta Railway, is a high road, the distance being 26 miles. A plentiful supply of good water is found throughout the year in the Kala Nadi at Bomanhalli, so that, in many ways, the place is suitable for a factory site. The disadvantages are that it is out of the way and that though it is close to the bamboo forests, the distance over which supplies, chemicals and coal would have to be carted, is not only considerable but might present serious difficulties during the rains.

The other possible site is Hubli, a station on the Madras and Southern Mahratta Railway, an average distance of 35 miles from the centre of the forests. Three main roads, running through the area, go to Hubli, the gradients over their entire length being in no case excessive or long, as the country is everywhere practically flat. This place has several advantages over the Bomanhalli site. Hubli is a fairly large station, and also has a good climate, besides which, chemicals, coal and labour would be far more easily procurable.

(6) *Outturn.*

The outturn is based on *Bambusa arundinacea* only, as the other species are not plentiful, besides being already in considerable demand. Five sample plots were taken by Mr. Butterworth, Assistant Conservator of Forests, in blocks XIV and XV (see Appendix V) giving a yield of

5,461 lbs. of dry internodes per acre. The area of the forests is 113,600 acres, so that the total yield works out to 617,420,660 lbs. or 275,143 tons. By cutting over the area in five years the sustained yield works out to 55,028 tons of dry internodes per annum. The total may be raised 15 per cent. if the nodes are taken into account.

(7) *Lines of export.*

(*i*) *To Bomanhalli.*—The area is well supplied with roads. The Alnawar-Kadra main road runs through Bomanhalli. Block XIII is tapped by the Yellapur main road, 13 miles being the distance from the centre of the area to the factory site. Blocks XIV and XV are tapped by feeder roads, giving on to main road, a distance of 15 miles from Bomanhalli. The bamboos in blocks XVI, XVIII and XXIII will have to be carted over the Yellapur-Alnawar main roads, an average distance of 31 miles.

(*ii*) *To Hubli.*—Were Hubli taken as the site for the factory, the bamboos from blocks XIII, XIV and XV would have to be carted over the Yellapur-Hubli main road, a distance of 30 miles; those from blocks XVI, XVIII and XXIII by the Sirsi-Hubli main road, a distance of 40 miles.

The average distance of carting, therefore, works out to 18 miles in the case of Bomanhalli and 35 miles in the case of Hubli.

(8) *Cost of cutting and extraction.*

The cost of cutting 100 bamboos is put at Rs. 5, that is, one rupee less than was the case below the Ghats. The reason for this is that the culms are not so large in this locality as they are in the Karwar and Ankola forests. A cart can take 1,200 lbs. of bamboos. One hundred dry bamboos weigh 3,720 lbs. (see Appendix V), therefore 100 bamboos furnish three cart-loads. The cost of carting is $2\frac{1}{2}$ annas per mile, therefore the cost of carting 100 dry bamboos to Bomanhalli, an average distance of 18 miles, comes to Rs. 8-7 and to Hubli, an average distance of 35 miles, Rs. 16-6 per 100.

(9) *Cost of landing air-dried internodes per ton at the factory site.*

The cost of landing dry internodes at Bomanhalli, therefore, works out to Rs. 8-6 per ton and at Hubli at Rs. 13-1 per ton. Were the nodes to be taken into account, the rate would be reduced by 15 per cent.

(10) *Labour.*

Cooly labour will undoubtedly be a difficulty in this locality. It is obtainable, in limited quantities, at 5 to 7 annas a day for men and 2½ to 3 annas for women, who, in these parts, are hardworking. It would undoubtedly be necessary to import labour either from the coast or from the neighbouring Deccan districts.

(11) *Chemicals.*

Good limestone rock occurs at Churanhukli about 12 miles north-west of Yellapur and about 15 miles from Bomanhalli. Shell-lime is also procurable in large quantities on the coast at a distance of 70 miles. The other necessary chemicals will have to be imported.

(12) *Firewood.*

Fairly large quantities of fuel are always available from these forests and would contribute largely to supply a mill at Bomanhalli. At Hubli it would be necessary to use coal.

(13) *Miscellaneous facts.*

Most of the roads in this locality are metalled, and therefore extraction by cart is possible practically throughout the year. This is not the case when floating is employed as in the Gangavalli and Kala Nadi areas, where the rivers are low in April and May.

The climate of this tract of forest is, on the whole, better than in the two previous areas dealt with, while, as far as the factory sites are concerned, Hubli is preferable to Bomanhalli in this respect. The difficulty will be in obtaining sufficient labour, to which point careful attention will have to be paid before any steps are taken to establish a mill.